Tracking of photospheric shock waves in computational fluid dynamics data by means of post-processing detection algorithms based on edge detection and shock surface normals computation

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Abstract

Simulations of the solar convection including radiation transport allow us to examine and track photospheric shock waves in detail unparalleled by direct observation. It is still not clear which processes trigger shocks and how significant a role they play for the energy transport to the upper layers of the atmosphere. Apart from traditional techniques of shock wave detection that rely on a search for the concentration of contour lines of pressure, density, and temperature and for the localization of Mach number isosurfaces, we employ recent post-processing methods specifically aimed at the analysis of computational fluid dynamics (CFD) data that allow us to more accurately locate and segment shock fronts as they propagate through the photospheric plasma. We present an application of different detection algorithms on radiation hydrodynamics (RHD) and radiation magnetohydrodynamics (RMHD) simulation data of the photosphere that are based on an edge detection technique as well as a method to locate shock surface normals based on the local pressure gradient. We will compare the emergence of shock patterns in these two qualitatively different simulations and discuss the correlation of the shock structures with the underlying flow field.